

WHAT IS CLAIMED IS:

1. A variable gain differential amplifier comprising:
 - a first transistor having a first terminal receiving a first input signal, a second terminal connected to a first potential via a first load, and a third terminal connected to a second potential via a first impedance device;
 - a second transistor having a first terminal receiving a second input signal, a second terminal connected to said first potential via a second load, and a third terminal connected to said second potential via a second impedance device; and
 - a variable impedance circuit connected between said third terminal of said first transistor and said third terminal of said second transistor, wherein
 - 15 said variable impedance circuit includes a first resistive element, a variable impedance device, and a second resistive element connected in series between said third terminal of said first transistor and said third terminal of said second transistor, and
 - 20 a control voltage is applied to a control terminal of said variable impedance device.

2. A multiplier comprising:

- first, second, third, fourth, fifth, and sixth transistors
 - 25 each having a first terminal, a second terminal, and a third

terminal; and

a variable impedance circuit, wherein
said first terminal of said first transistor receives
a first input signal, said second terminal thereof is connected
5 to a first potential via a first load, and said third terminal
thereof is connected to said second terminal of said fifth
transistor;

said first terminal of said second transistor receives
a second input signal, said second terminal thereof is connected
10 to said first potential via a second load, and said third terminal
thereof is connected to said second terminal of said fifth
transistor;

said first terminal of said third transistor receives
said second input signal, said second terminal thereof is
15 connected to said first potential via said first load, and said
third terminal thereof is connected to said second terminal
of said sixth transistor;

said first terminal of said fourth transistor receives
said first input signal, said second terminal thereof is
20 connected to said first potential via said second load, and
said third terminal thereof is connected to said second terminal
of said sixth transistor;

said first terminal of said fifth transistor receives
a third input signal, and said third terminal thereof is connected
25 to a second potential via a first impedance device;

said first terminal of said sixth transistor receives a fourth input signal, and said third terminal thereof is connected to said second potential via a second impedance device, and wherein

5 said variable impedance circuit includes a first resistive element, a variable impedance device, and a second resistive element connected in series between said third terminal of said fifth transistor and said third terminal of said sixth transistor, and wherein

10 a control voltage is applied to a control terminal of said variable impedance device.

3. A variable impedance circuit including:

15 first and second nodes each supplied with an equivalent potential; and

 a first resistive element, a variable impedance device, and a second resistive element connected in series between said first node and said second node, wherein

20 a control voltage is applied to a control terminal of said variable impedance device.

4. A variable gain differential amplifier comprising:

 a first transistor having a first terminal receiving a first input signal, a second terminal connected to a first potential via a first load, and a third terminal connected to

a second potential via a first impedance device;

5 a second transistor having a first terminal receiving a second input signal, a second terminal connected to said first potential via a second load, and a third terminal connected to said second potential via a second impedance device; and

a variable impedance circuit connected between said third terminal of said first transistor and said third terminal of said second transistor, wherein

said variable impedance circuit includes:

10 first and second variable impedance devices connected in series between said third terminal of said first transistor and said third terminal of said second transistor; and

15 a resistive element connected between a junction point between said first variable impedance device and said second variable impedance device and said second potential, and wherein

a control voltage is applied to a control terminal of said first and second variable impedance devices.

5. A multiplier comprising:

20 first, second, third, fourth, fifth, and sixth transistors each having a first terminal, a second terminal, and a third terminal; and

a variable impedance circuit, wherein

25 said first terminal of said first transistor receives a first input signal, said second terminal thereof is connected

to a first potential via a first load, and said third terminal thereof is connected to said second terminal of said fifth transistor;

5 said first terminal of said second transistor receives a second input signal, said second terminal thereof is connected to said first potential via a second load, and said third terminal thereof is connected to said second terminal of said fifth transistor;

10 said first terminal of said third transistor receives said second input signal, said second terminal thereof is connected to said first potential via said first load, and said third terminal thereof is connected to said second terminal of said sixth transistor;

15 said first terminal of said fourth transistor receives said first input signal, said second terminal thereof is connected to said first potential via said second load, and said third terminal thereof is connected to said second terminal of said sixth transistor;

20 said first terminal of said fifth transistor receives a third input signal, and said third terminal thereof is connected to a second potential via a first impedance device;

25 said first terminal of said sixth transistor receives a fourth input signal, and said third terminal thereof is connected to said second potential via a second impedance device, and wherein

said variable impedance circuit includes:

first and second variable impedance devices connected in series between said third terminal of said fifth transistor and said third terminal of said sixth transistor; and

5 a resistive element connected between a junction point between said first variable impedance device and said second variable impedance device and said second potential, and wherein a control voltage is applied to a control terminal of said first and second variable impedance devices.

10

6. A variable impedance circuit comprising:

first, second, third, fourth, and fifth nodes;

first and second variable impedance devices connected between said first node and said second node;

15 a first resistive element connected between said first node and said third node;

a second resistive element connected between said second node and said fourth node; and

20 a third resistive element connected between a junction point between said first variable impedance device and said second variable impedance device and said fifth node, wherein said first, second, third, fourth, and fifth nodes are supplied with first, second, third, fourth, and fifth potentials, respectively,

25 said first and second potentials being equal, and wherein

a control voltage is applied to a control terminal of said first and second variable impedance devices.

7. A high-frequency circuit comprising:

5 a differential amplifier that receives first and second input signals; and

a multiplier, wherein

said differential amplifier comprises:

10 a first transistor having a first terminal receiving a first input signal, a second terminal connected to a first potential via a first load, and a third terminal connected to a second potential via a first impedance device;

15 a second transistor having a first terminal receiving a second input signal, a second terminal connected to said first potential via a second load; and a third terminal connected to said second potential via a second impedance device; and

a variable impedance circuit connected between said third terminal of said first transistor and said third terminal of said second transistor,

20 said variable impedance circuit including a first resistive element, a variable impedance device, and a second resistive element connected in series between said third terminal of said first transistor and said third terminal of said second transistor,

25 a control voltage being applied to a control terminal

of said variable impedance device, and wherein

said multiplier comprises:

first, second, third, fourth, fifth, and sixth transistors
each having a first terminal, a second terminal, and a third
5 terminal; and

a variable impedance circuit,

10 said first terminal of said first transistor receiving
a third input signal, said second terminal thereof being
connected to a first potential via a first load, said third
terminal thereof being connected to said second terminal of
said fifth transistor;

15 said first terminal of said second transistor receiving
a fourth input signal, said second terminal thereof being
connected to said first potential via a second load, said third
terminal thereof being connected to said second terminal of
said fifth transistor;

20 said first terminal of said third transistor receiving
said fourth input signal, said second terminal thereof being
connected to said first potential via said first load, said
third terminal thereof being connected to said second terminal
of said sixth transistor;

25 said first terminal of said fourth transistor receiving
said third input signal, said second terminal thereof being
connected to said first potential via said second load, said
third terminal thereof being connected to said second terminal

of said sixth transistor;

 said first terminal of said fifth transistor receiving
 a fifth input signal, said third terminal thereof being connected
 to a second potential via a first impedance device;

5 said first terminal of said sixth transistor receiving
 a sixth input signal, said third terminal thereof being connected
 to said second potential via a second impedance device,

 said variable impedance circuit including a first
 resistive element, a variable impedance device, and a second
10 resistive element connected in series between said third
 terminal of said fifth transistor and said third terminal of
 said sixth transistor,

 a control voltage being applied to a control terminal
 of said variable impedance device, and wherein

15 output signals at said second terminals of said first
 and second transistors in said differential amplifier are
 applied to said first terminals of said fifth and sixth
 transistors in said multiplier as said fifth and sixth input
 signals, and wherein

20 a first control voltage is applied to said variable
 impedance circuit in said differential amplifier, and a second
 control voltage is applied to said variable impedance circuit
 in said multiplier.

25 8. A high-frequency circuit comprising:

a differential amplifier that receives first and second input signals; and

a multiplier, wherein

said differential amplifier comprises:

5 a first transistor having a first terminal receiving a first input signal, a second terminal connected to a first potential via a first load, and a third terminal connected to a second potential via a first impedance device;

10 a second transistor having a first terminal receiving a second input signal, a second terminal connected to said first potential via a second load, and a third terminal connected to said second potential via a second impedance device; and

15 a variable impedance circuit connected between said third terminal of said first transistor and said third terminal of said second transistor,

20 said variable impedance circuit including a first resistive element, a variable impedance device, and a second resistive element connected in series between said third terminal of said first transistor and said third terminal of said second transistor,

25 a control voltage being applied to a control terminal of said variable impedance device, and wherein

said multiplier comprises:

first, second, third, fourth, fifth, and sixth transistors
25 each having a first terminal, a second terminal, and a third

terminal; and

a variable impedance circuit,

said first terminal of said first transistor receiving
a third input signal, said second terminal thereof being
5 connected to a first potential via a first load, said third
terminal thereof being connected to said second terminal of
said fifth transistor;

10 said first terminal of said second transistor receiving
a fourth input signal, said second terminal thereof being
connected to said first potential via a second load, said third
terminal thereof being connected to said second terminal of
said fifth transistor;

15 said first terminal of said third transistor receiving
said fourth input signal, said second terminal thereof being
connected to said first potential via said first load, said
third terminal thereof being connected to said second terminal
of said sixth transistor;

20 said first terminal of said fourth transistor receiving
said third input signal, said second terminal thereof being
connected to said first potential via said second load, said
third terminal thereof being connected to said second terminal
of said sixth transistor;

25 said first terminal of said fifth transistor receiving
a fifth input signal, said third terminal thereof being connected
to a second potential via a first impedance device;

said first terminal of said sixth transistor receiving
 a sixth input signal, said third terminal thereof being connected
 to said second potential via a second impedance device,

 said variable impedance circuit including:

5 first and second variable impedance devices connected
 in series between said third terminal of said fifth transistor
 and said third terminal of said sixth transistor; and

 a resistive element connected between a junction point
 between said first variable impedance device and said second
10 variable impedance device and said second potential,

 a control voltage being applied to a control terminal
 of said first and second variable impedance devices, and wherein

 output signals at said second terminals of said first
 and second transistors in said differential amplifier are
15 applied to said first terminals of said fifth and sixth
 transistors in said multiplier as said fifth and sixth input
 signals, and wherein

 a first control voltage is applied to said variable
 impedance circuit in said differential amplifier, and a second
20 control voltage is applied to said variable impedance circuit
 in said multiplier.

9. A high-frequency circuit comprising:

 a differential amplifier that receives first and second
25 input signals; and

a multiplier, wherein

said variable gain differential amplifier comprises:

5 a first transistor having a first terminal receiving a first input signal, a second terminal connected to a first potential via a first load, and a third terminal connected to a second potential via a first impedance device;

10 a second transistor having a first terminal receiving a second input signal, a second terminal connected to said first potential via a second load, and a third terminal connected to said second potential via a second impedance device; and

a variable impedance circuit connected between said third terminal of said first transistor and said third terminal of said second transistor,

said variable impedance circuit including:

15 first and second variable impedance devices connected in series between said third terminal of said first transistor and said third terminal of said second transistor; and

20 a resistive element connected between a junction point between said first variable impedance device and said second variable impedance device and said second potential,

a control voltage being applied to a control terminal of said first and second variable impedance devices, and wherein

said multiplier comprises:

first, second, third, fourth, fifth, and sixth transistors
25 each having a first terminal, a second terminal, and a third

terminal; and

a variable impedance circuit,

said first terminal of said first transistor receiving
a third input signal, said second terminal thereof being
5 connected to a first potential via a first load, said third
terminal thereof being connected to said second terminal of
said fifth transistor;

10 said first terminal of said second transistor receiving
a fourth input signal, said second terminal thereof being
connected to said first potential via a second load, said third
terminal thereof being connected to said second terminal of
said fifth transistor;

15 said first terminal of said third transistor receiving
said fourth input signal, said second terminal thereof being
connected to said first potential via said first load, said
third terminal thereof being connected to said second terminal
of said sixth transistor;

20 said first terminal of said fourth transistor receiving
said third input signal, said second terminal thereof being
connected to said first potential via said second load, said
third terminal thereof being connected to said second terminal
of said sixth transistor;

25 said first terminal of said fifth transistor receiving
a fifth input signal, said third terminal thereof being connected
to a second potential via a first impedance device;

said first terminal of said sixth transistor receiving
 a sixth input signal, said third terminal thereof being connected
 to said second potential via a second impedance device,

 said variable impedance circuit including a first
5 resistive element, a variable impedance device, and a second
 resistive element connected in series between said third
 terminal of said fifth transistor and said third terminal of
 said sixth transistor,

 a control voltage being applied to a control terminal
10 of said variable impedance device, and wherein

 output signals at said second terminals of said first
 and second transistors in said differential amplifier are
 applied to said first terminals of said fifth and sixth
 transistors in said multiplier as said fifth and sixth input
15 signals, and wherein

 a first control voltage is applied to said variable
 impedance circuit in said differential amplifier, and a second
 control voltage is applied to said variable impedance circuit
 in said multiplier.

20

 10. A high-frequency circuit comprising:

 a differential amplifier that receives first and second
 input signals; and

 a multiplier, wherein

25 said differential amplifier comprises:

a first transistor having a first terminal receiving a first input signal, a second terminal connected to a first potential via a first load, and a third terminal connected to a second potential via a first impedance device;

- 5 a second transistor having a first terminal receiving a second input signal, a second terminal connected to said first potential via a second load, and a third terminal connected to said second potential via a second impedance device; and
10 a variable impedance circuit connected between said third terminal of said first transistor and said third terminal of said second transistor.

 said variable impedance circuit including:

- first and second variable impedance devices connected in series between said third terminal of said first transistor
15 and said third terminal of said second transistor; and

 a resistive element connected between a junction point between said first variable impedance device and said second variable impedance device and said second potential,

- a control voltage being applied to a control terminal
20 of said first and second variable impedance devices, and wherein
 said multiplier comprises:

 first, second, third, fourth, fifth, and sixth transistors each having a first terminal, a second terminal, and a third terminal; and

- 25 a variable impedance circuit,

5 said first terminal of said first transistor receiving
a third input signal, said second terminal thereof being
connected to a first potential via a first load, said third
terminal thereof being connected to said second terminal of
5 said fifth transistor;

10 said first terminal of said second transistor receiving
a fourth input signal, said second terminal thereof being
connected to said first potential via a second load, said third
terminal thereof being connected to said second terminal of
10 said fifth transistor;

15 said first terminal of said third transistor receiving
said fourth input signal, said second terminal thereof being
connected to said first potential via said first load, said
third terminal thereof being connected to said second terminal
15 of said sixth transistor;

20 said first terminal of said fourth transistor receiving
said third input signal, said second terminal thereof being
connected to said first potential via said second load, said
third terminal thereof being connected to said second terminal
20 of said sixth transistor;

 said first terminal of said fifth transistor receiving
a fifth input signal, said third terminal thereof being connected
to a second potential via a first impedance device;

25 said first terminal of said sixth transistor receiving
a sixth input signal, said third terminal thereof being connected

to said second potential via a second impedance device,

said variable impedance circuit including:

first and second variable impedance devices connected
in series between said third terminal of said fifth transistor
5 and said third terminal of said sixth transistor; and

a resistive element connected between a junction point
between said first variable impedance device and said second
variable impedance device and said second potential,

10 a control voltage being applied to a control terminal
of said first and second variable impedance devices, and wherein

output signals at said second terminals of said first
and second transistors in said differential amplifier are
applied to said first terminals of said fifth and sixth
transistors in said multiplier as said fifth and sixth input
15 signals, and wherein

a first control voltage is applied to said variable
impedance circuit in said differential amplifier, and a second
control voltage is applied to said variable impedance circuit
in said multiplier.

20

11. A high-frequency circuit comprising:

a differential amplifier; and

a multiplier, wherein

said differential amplifier comprises:

25 a first transistor having a first terminal receiving a

first input signal, a second terminal connected to a first potential via a first load, and a third terminal connected to a second potential via a first impedance device;

5 a second transistor having a first terminal receiving a second input signal, a second terminal connected to said first potential via a second load, and a third terminal connected to said second potential via a second impedance; and

10 a first variable impedance circuit having an impedance connected to said third terminal of said first transistor and said third terminal of said second transistor and varying depending on a first control voltage, and wherein

 said multiplier includes first, second, third, fourth, fifth, and sixth transistors each having a first terminal, a second terminal, and a third terminal; and

15 a second variable impedance circuit,

 said first terminal of said first transistor receiving a third input signal, said second terminal thereof being connected to a first potential via a first load, said third terminal thereof being connected to said second terminal of
20 said fifth transistor;

 said first terminal of said second transistor receiving a fourth input signal, said second terminal thereof being connected to said first potential via a second load, said third terminal thereof being connected to said second terminal of
25 said fifth transistor;

5 said first terminal of said third transistor receiving
said fourth input signal, said second terminal thereof being
connected to said first potential via said first load, said
third terminal thereof being connected to said second terminal
of said sixth transistor;

10 said first terminal of said fourth transistor receiving
said third input signal, said second terminal thereof being
connected to said first potential via said second load, said
third terminal thereof being connected to said second terminal
of said sixth transistor;

 said first terminal of said fifth transistor receiving
a fifth input signal, said third terminal thereof being connected
to said second potential via a first impedance device;

15 said first terminal of said sixth transistor receiving
a sixth input signal, said third terminal thereof being connected
to said second potential via a second impedance device,

20 said second variable impedance circuit being connected
between said third terminal of said fifth transistor and said
third terminal of said sixth transistor and having an impedance
varying depending on a second control voltage, and wherein

25 output signals at said second terminals of said first
and second transistors in said differential amplifier are
applied to said first terminals of said fifth and sixth
transistors in said multiplier as said fifth and sixth input
signals.

12. A high-frequency circuit comprising:

a variable gain differential amplifier that receives first
and second input signals in a predetermined frequency range;

5 and

a variable gain multiplier from which first and second
output signals having a constant frequency are derived, wherein
gains of said variable differential amplifier and said
variable gain multiplier are controlled by a common control
10 voltage.

13. A differential distributed amplifier comprising:

a first transmission circuit composed of a plurality of
inductive elements receiving a first signal;

15 a second transmission circuit composed of a plurality
of inductive elements receiving a second input signal;

a third transmission circuit composed of a plurality of
inductive elements;

20 a fourth transmission circuit composed of a plurality
of inductive elements; and

a plurality of differential amplifiers, wherein
each of said plurality of differential amplifiers
comprises:

25 a first transistor having a first terminal connected to
any of said plurality of inductive elements of said first

transmission circuit, a second terminal connected to any of said plurality of inductive elements of said third transmission circuit, and a third terminal;

a second transistor having a first terminal connected
5 to any of said plurality of inductive elements of said second transmission circuit, a second terminal connected to any of said plurality of inductive elements of said fourth transmission circuit, and a third terminal; and

a variable impedance circuit connected between said third
10 terminal of said first transistor and said third terminal of said second transistor, and wherein

said variable impedance circuit includes:

first and second variable impedance devices connected
between said third terminal of said first transistor and said
15 third terminal of said second transistor; and

a resistive element connected between a junction point
between said first variable impedance device and said second
variable impedance device and a reference voltage, and wherein
a control voltage is applied to a control terminal of
20 said first and second variable impedance devices.

14. The differential distributed amplifier according
to Claim 13, wherein

said resistive element includes a constant current source.

15. The differential distributed amplifier according to Claim 13, wherein

each of said plurality of differential amplifiers further includes:

5 a first impedance device connected between said third terminal of said first transistor and a reference potential; and

a second impedance device connected between said third terminal of said second transistor and a reference potential.

10

16. The differential distributed amplifier according to Claim 15, wherein

said first and second impedance devices include a resistance.

15

17. The differential distributed amplifier according to Claim 15, wherein

said first and second impedance devices include a constant current source.

20

18. The differential distributed amplifier according to Claim 15, wherein

said resistive element includes a constant current source.

25

19. The differential distributed amplifier according

to Claim 13, wherein

each of said plurality of differential amplifiers further includes:

a third transistor having a first terminal receiving a
5 bias voltage; and

a fourth transistor having a first terminal receiving a bias voltage,

said first and third transistors being cascode-connected,
said second and fourth transistors being cascode-connected,

10 said second terminal of said first transistor being connected via said third transistor to any of said plurality of inductive elements of said third transmission circuit,

said second terminal of said second transistor being connected via said fourth transistor to any of said plurality 15 of inductive elements of said fourth transmission circuit.